

# Structural Org. In Animals

- In unicellular organisms → single cell performs all functions like → digestion  
Respiration  
Reproduction

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- In complex body of multicellular → basic functions are carried by different groups of cells in a well organised manner.

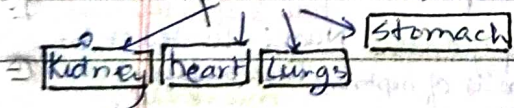
→ Body of hydra → made of different types of cells & the no. in each type can be thousands.

→ Human body → composed of billions of cells to perform various functions. Billions

(1) TISSUE → In multicellular animals, a group of similar cells along with intercellular substance perform specific function.

★ All complex animals consist of only 4 basic types of tissues ★

(2) ORGANS → Tissues are organised in specific proportion & pattern.

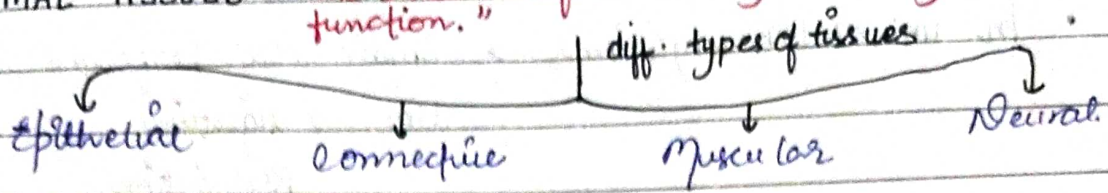


(3) ORGAN SYSTEM → When two or more organs perform a common function by their physical and/or chemical interactions.

\* Cells, tissues, organs & organ systems split up the work in a way that exhibits division of labour & contribute to the survival of body as a whole.\*



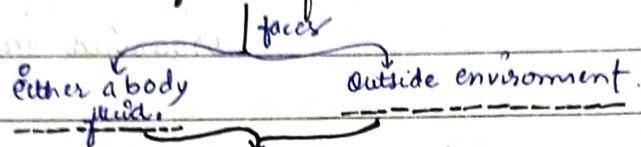
ANIMAL TISSUES → "V. Imp"   
 "The structure of cells vary according to their function."



## EPITHELIAL TISSUE

Referred as epithelium (pl: epithelia)

→ This tissue → Has a free surface



★ thus provides a covering or a lining for some part of body ★

→ Cells : Compactly packed with little intercellular matrix.

Two types of epithelial tissue

Simple Epithelium

Composed of a single layer of cells

Functions as lining for body cavities

→ Ducts  
→ Tubes

Compound epithelium

Consists of two or more cell layers

Functions protection (as in skin)

Squamous Epithelium

- Made of single thin layer of flattened cells with irregular boundaries.
- Found in walls of blood vessels

→ Air sacs of lungs

• Functions → Forms a diffusion boundary

Cuboidal Epithelium

- Made of single layer of cube like cells
- Found in Ducts of glands  
Tubular parts of nephron in kidney

• Functions are secretions & absorption

\*The epithelium of PCT of nephron in kidney has microvilli.

Columnar Epithelium

- Composed of single layer of tall & slender cells.
- Nuclei - Located at base
- Free surface - have microvilli.

• Found in lining of stomach & intestine.

• Functions in secretion & absorption.

When cuboidal & columnar epithelium bear cilia on free surface, they are called ciliated epithelium.

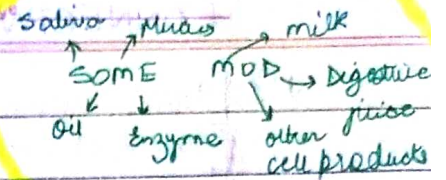
Function: Move particles / mucus in specific direction over the epithelium.

Found in: Inner surface of hollow organs like → bronchioles  
→ Fallopian tubes.





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⇒ Some of the columnar or cuboidal cells

↓  
get specialised for secretion  
are ↓ called.

"Glandular Epithelium"

On the basis of mode of pouring of their secretions.

Two types

↓  
Unicellular

↓  
consisting of isolated glandular cells

Ex: goblet cells of the alimentary canal.

columnar

↓  
Multicellular

↓  
consisting of clusters of cells

Ex: Salivary Gland

Exocrine

secrete → mucus  
→ saliva  
→ tear water  
→ oil  
→ digestive enzymes  
→ other cell products.

• The products are released through ducts or tubes.

Endocrine

• These don't have ducts.

• Secrete hormones

↓  
directly into the fluid bathing the gland.

(COMPOUND EPITHELIUM)

Made of more than one layer (multilayered) of cells

Has a limited role in secretion & absorption

Main function - Provide protection against

(chemical stress)

(mechanical stress)

• They cover → dry surface of the skin

① Moist surface of buccal cavity, pharynx

② Inner lining of ducts of Salivary Glands  
③ pancreatic ducts.

\* All cells in Epithelium are held together with little intercellular material.

In nearly all animal tissues, specialised junctions provide both

(structural link) (functional link)

(in epithelium & other tissues)

Three types of Junctions

Tight junction

Stop substance from leaking across a tissue.

Adhering junction

Perform cementing to keep neighbouring cells together.

rapid transfer of  $D^+$  ions

Gap junctions

facilitate the cells to communicate with each other by connecting cytoplasm of adjoining cells



Diverse types of connective tissue bind together  
support  
strengthen  
protect  
insulate

## CONNECTIVE TISSUE

- Most abundant
- Most widely distributed in the body of complex animals.
- Consists all 3 types of tissue

Function: Linking & supporting other tissues / organs of the body.

Range: from soft connective tissues to specialized type.

cartilage bone adipose blood.

- In all connective tissues except blood, the cells secrete fibres of structural proteins called collagen or elastin.\*

Fibres provide  $\left\{ \begin{array}{l} \rightarrow \text{strength} \\ \rightarrow \text{elasticity} \\ \rightarrow \text{flexibility} \end{array} \right\}$  to the tissue

These cells also secrete  $\rightarrow$  modified polysaccharides

accumulate b/w cells & fibres and act as matrix (ground substance)

### THREE TYPES

#### LOOSE CONNECTIVE TISSUE

Has cells & fibres loosely arranged in a semi fluid ground substance.

##### AREOLAR TISSUE

- Present beneath the skin.
- Serves as support framework for epithelium.
- It contains fibroblasts (cells that produce & secrete fibres), macrophages, mast cells.

##### ADIPOSE TISSUE

- Present beneath the skin.
- Cells specialised to store fats.
- The excess of nutrients which are not used immediately are converted into fats & stored in this tissue.

#### DENSE CONNECTIVE TISSUE

- Fibres & fibroblasts are completely packed.
- Orientation of fibres show a regular or irregular pattern.

##### Dense regular

Collagen fibres present in rows b/w many parallel bundles of fibres.

Tendons

MTB

##### Dense irregular

Has fibroblasts and many fibres (mostly collagen) that are oriented differently.

This tissue is present in skin.

Ligaments

BLB

#### SPECIALISED CONNECTIVE TISSUE

Cartilage Bone Blood.

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## Cartilage

## Bones

## Blood



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Intercellular material is solid & pliable & resist compression.

Cells of this tissue - chondrocytes are enclosed in small cavities, within the matrix secreted by them.

Most of the cartilages in vertebrate embryos are replaced by bones in adults.

Present at the

- 1) tip of nose
- 2) outer ear joints
- 3) b/w adjacent bones of vertebral column, limbs, hands in adults.

Have hard & nonpliable ground substance rich in calcium salts & collagen fibres which give strength.

It is main tissue providing structural frame to the body.

"Bones support & protect softer tissues & organs".

The bone cells osteocytes are present in spaces lacunae.

Limb bones, such as long bones of the legs, serve weight bearing functions.

They also interact with skeletal muscles attached to them to bring about movements.

The bone marrow in some bones is the site of production of blood cells.

Fluid connective tissues containing plasma, RBC, WBC, platelets.

Main circulating fluid that helps in transport of various substance.

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## MUSCLE TISSUES

Each muscle → made up of many long, cylindrical fibres arranged in parallel arrays.

These fibres are composed of fine fibrils, called myofibrils of numerous.

Muscle fibre → contract in response to stimulation (shorten)

then relax (lengthen) & return to uncontracted state in co-ordinated fashion, moves the body → to adjust to the changes in the environment & to maintain the positions of various parts of body. In general, muscles play an active role in all movements of body.



## Muscles 3 types

### Skeletal muscles

- Closely attached to skeletal bones.
- In typical muscles, such as biceps, these muscles are bundled together in parallel fashion.
- A sheath of tough connective tissue encloses several bundles of muscle fibres.

### Smooth muscles

- Fibres taper at both ends (fusiform) & do not show striations.

• Cell junctions hold them together & they are bundled together in connective tissue sheath.

- Found in walls of internal organs such as blood vessels, stomach & intestine.

• Involuntary as their functions cannot be directly controlled.

### Cardiac muscles

Contractile tissue present only in heart.

• Cell junctions fuse the plasma membrane of cardiac muscle cells & make them stick together.

• Communication junction (intercalated disc) at some fusion points allow the cells to contract as a unit.  
i.e. when one cell receives a signal to contract, its neighbours are stimulated to contract.

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## NEURAL TISSUES

"This tissue exerts the greatest control over the body's responsiveness to changing conditions".

Neurons - unit of neural system are excitable cells.

Neuroglial cells - constitute rest of neural system protect & support neurons.

Neuroglia - make up more than one-half the volume of neural tissue in our body.

When neuron is suitably stimulated, an electrical disturbance is generated which swiftly travels along its plasma membrane.

Arrival of disturbance at neuron ending, or output zone, triggers events that may cause stimulation or inhibition of adjacent neurons & other cells.



→ Adult common species: *Periplaneta Americana*



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# COCKROACH

Brown or Black bodied animals.

Class: Insecta

Phylum: Arthropoda.

Size & Range:  $\frac{1}{4}$  inches to 3 inches  
(0.6 - 7.6 cm)

Colour: Bright yellow  
Red  
Green

in tropical regions.

They have <sup>①</sup> long antennae, <sup>②</sup> legs & <sup>③</sup> flat extensions of upper body wall that conceals head.

"Nocturnal omnivores" → live in damp places throughout the world.

"They are residents of human homes, & thus are serious <sup>①</sup> pests and <sup>②</sup> vectors of several disease."

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## MORPHOLOGY:

★ Length: 34 - 53 mm ★

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"Wings that extend beyond the tip of the abdomen in males"

Body: Segmented, body divisible into  
head → thorax → Abdomen.

Entire body covered with: Chitinous exoskeleton. (brown in colour)

- In each segment, (exoskeleton) has hardened plates called **sclerites**

joined to each other by <sup>①</sup> thin & <sup>②</sup> flexible articular membrane (arthrodial membrane)

tergites dorsally

sternites ventrally

**Head** →  $\Delta$  (triangular) shape

→ lies anteriorly at  $\perp$  to the longitudinal body axis.

→ Formed by fusion of 6 segments → hence shows great mobility in all directions  
flexible neck ← due to

★ Head Capsule: bears a pair of compound eyes

Pair of thread like structure. **Antennae** → Arise from membranous sockets  
Lying in front of eyes

have sensory receptors - that help in monitoring the environment.





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Ant. end of head → bears appendages

Biting & chewing type of mouth parts

Labrum (upper lip)

Pair of mandibles

Pair of maxillae

Labium (lower lip)

Hypopharynx

Thorax

Prothorax

Mesothorax

Metathorax

2nd seg ment

(1st pair of wings)

3rd seg ment

(2nd pair of wings)

Head ← connected with thorax → by a short extension of prothorax

NECK

Each thoracic segment bears A pair of walking legs

Tegmina

Forewings

- opaque
- Dark
- leathery
- Cover hindwings at rest

Hindwings

- Transparent
- Membranous
- Used in flight

Abdomen

Consists of 10 segments

Males

Females

hind end of abdomen bounded

Dorsally by 9th & 10th terga

Ventrally by 8th sternum

forms

Genital pouch/chamber

contains:

- 1.) Dorsal anus
- 2.) Ventral male genital pore/gonopore
- 3.) Gonapophysis → represents external genitalia

7th Sternum - Boat shaped

7th

8th

9th

These sternums join together

Brood or genital pouch

anterior part

- Female gonopore
- Spermathecal pores
- Coelateral glands (pair)

absent in females

Males bear → pair of short, thread like anal styles

Both sexes → 10th segment bears pair of jointed filamentous structures and cerci.



# ANATOMY

A pair of salivary gland present near crop

## Alimentary canal

present in body cavity

Foregut

Midgut

Hindgut

Mouth

opens into

Pharynx

• Short  
• Tubular

(2 pairs)

Salivary gland

(1 pair)

Salivary reservoir

• Sac-like  
• Stores food

Crop

Oesophagus

• narrow  
• tubular passage

Proventriculus / Gizzard

• Outer layer: Thick, circular muscles

• Inner: Thick cuticle

6 highly chitinous plate → teeth

• Helps in grinding the food particle.

Hepatic caecae / Gastric caecae

• Ring of 6-8 blind tubules

• Present at junction of midgut & foregut

• Secrete digestive juice

Malpighian tubules

• At junction of midgut & hindgut

• 100-150

• Removal of excretory products

• Yellow

• thin

• Filamentous

from haemolymph

Hindgut broadens midgut

Rectum

Colon

Rectum

opens through

Anus

Out

## BLOOD VASCULAR SYSTEM

Open type

BV: poorly developed

opens into

Space

Haemocoel

ke andar hole hi

Visceral organ

bathed in

blood

(haemolymph)

Heart

consists of

• Elongated muscular tube

• Lying along - dorsal line of thorax & abdomen

differentiated into

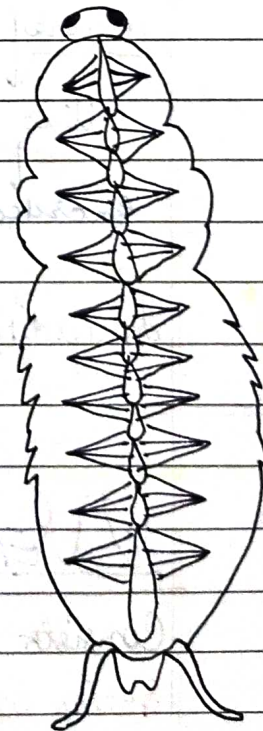
Funnel shaped chambers (with ostia on either side)

Stomachs

blood through ostia

heart

blood pumped anteriorly







## RESPIRATORY SYSTEM.

Consists of

↓  
network of trachea  $\xrightarrow[\text{through}]{\text{opens}}$  10 pairs of small holes (20 total)  
 $\rightarrow$  spiracles,  
present on lateral side of body.

Thin branching tubes (tracheal tubes  $\xrightarrow[\text{-ed}]{\text{subdivided}}$  tracheoles)  
↓  
carry  $O_2$  from air  $\rightarrow$  To body parts.

Opening of spiracles  $\rightarrow$  regulated by sphincters  
Exchange of gases  $\xrightarrow[\text{diffusion}]{\text{by}}$  At tracheoles

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## EXCRETORY SYSTEM

Excretion  $\xrightarrow[\text{by}]{\text{performed}}$  Malpighian tubules

Absorb nitrogenous waste products  
convert them into

Uric acid

↓  
Excreted through Hindgut

lined by

- Glandular cells
- Ciliated cells

"URICOTELIC"

In addition  $\xrightarrow{\text{FUN}}$   $\left. \begin{array}{l} \text{① Fat body} \\ \text{② Nephrocytes} \\ \text{③ Urecox glands} \end{array} \right\}$

$\rightarrow$  help in excretion

## NERVOUS SYSTEM

Consists of :

Series of  $\left. \begin{array}{l} \text{① fused} \\ \text{② segmentally arranged} \end{array} \right\} \rightarrow$  ganglia

$\rightarrow$  joined by paired longitudinal connectives on the ventral side.





3 ganglia at → thorax      6 ganglia at → abdomen

- \* The nervous system of cockroach is spread throughout the body\*.
- \* The head holds a bit of nervous system while rest is situated along the ventral (belly side) part of body\*

Hence, if head cut-off, it will still live for as long as 1 week

In head → Brain represented by → Supra Oesophageal ganglia

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antennae

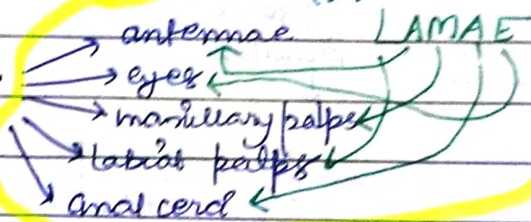
Compound eyes

supplies nerves to

(LAME)

LAME

Sense organs in Cockroach



Compound eyes → at dorsal surface of head.

Each eye → 2000 hexagonal ommatidia (sing: ommatidium)

With the help of several ommatidia → Cockroach receive several images of an object.

Vision : Mosaic → more sensitivity  
→ less resolution

Common during night → nocturnal vision

## REPRODUCTIVE SYSTEM

Cockroach : DIOECIOUS

Both sexes → Well developed reproductive organs

Internal fertilization



## Male

Pair of testis - On each lateral (1-1)  
→ 4th-6th segments (abdominal)

Each testis → arise → Vas deferens (pair)  
• thin  
pair ← Thorough/semin at vesicle. opens into Ejaculatory duct

Male gonopore opens into  
• Ventral to anus

• characteristic Mushroom gland → • mushroom shaped  
• 6th-7th abdominal segments  
• Function: Accessory reproductive gland.

External genitalia represented by Male gonapophysis or phallomere.

Sperm stored in Seminal vesicle  
↓  
Glued together → form Bundles  
↓  
spermatophores  
These are discharged during copulation.  
• Chitinous  
• Asymmetrical struct.  
• Surrounded by male gonopore

## Female

Pair of • Large Ovaries  
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lying laterally in 2-6th abdominal segment

Each ovary → formed by  
• group of 8 ovarian tubules / ovarioles.  
arise → contains a chain of developing ova.

Oviducts

• one pair

Vagina

• single oviducts  
• median

opens into

Genital chamber

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\* Sperm are transferred through spermatophore \*

Fertilized eggs encased in Capsules called "ootheca" → dropped of, glued → suitable surface.

Fertilization - Internal • Dark-reddish  
• 3/8" (8mm) long

On average, females

Rupture of single ootheca → 16 young ones, called nymphs come out  
→ produce 9-10 oothecae  
each contains 14-16 eggs

Development : PAUROMETABOLISM

→ development through nymphal stage.

Adult form reach About 13 times grows by moulting nymph

\* Next to nymphal stage has wing pads but only adult cockroach has wings. \*

Many species of cockroach → Wild, of no known economic importance  
Few species thrive in → Human habitat

They are pests  
↓  
Spoil food  
↓  
Contaminate

With smelly excreta